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COMMENT ON 'K_P DEPENDENCE ON SECTORS' BY I. B.
McDIARMID AND E. E. BUDZINSKI

STANFORD UNIVERSITY

PREPARED FOR
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MARCH 1976

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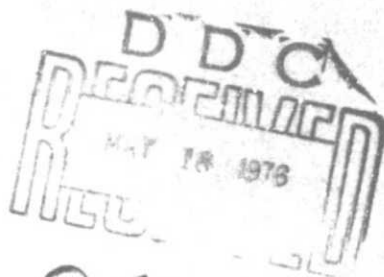
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Comment on 'Kp Dependence on
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E. E. Budzinski

by

Leif Svalgaard

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Comment on 'Kp Dependence on Sectors'

by I.B. McDiarmid and E.E. Budzinski

by

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McDiarmid and Budzinski (1975) examined the Kp-index as a function of the average geocentric solar magnetospheric (GSM) latitude of the interplanetary magnetic field. Their results seem to indicate that the Kp-index depends on $\cos \phi$, where ϕ is the angle between the average interplanetary magnetic field direction and the Z axis of the GSM coordinate system. Such a dependence is predicated by the merging theory of geomagnetic activity (Russell and McPherron, 1973; Svalgaard, 1976a). A striking feature of McDiarmid and Budzinski's analysis was that the correlation between Kp and $\cos \phi$ was present only when the polarity of the interplanetary magnetic field was directed towards the sun. During away polarity there was little or no correlation between Kp and $\cos \phi$. This difference between away and toward polarity was explained by McDiarmid and Budzinski in terms of an additional annual variation of geomagnetic activity. It is the purpose of the present note to point out that such an assumption is not necessary to explain the difference between the Kp dependence of $\cos \phi$ for the two sector polarities. The correct explanation is simply that Kp is not suited for the kind of analysis attempted by McDiarmid and Budzinski.

The angle ϕ depends both on time of year and on Universal Time. In constructing the Kp index it was realized that the Kp observatories were so unevenly distributed in longitude (most of them are in Europe) that true Universal Time variations would be masked by local time effects. As a consequence standardization tables are used to eliminate local time (and UT) variations. Ideally Kp should have no UT variation at all. As Michel (1964) points out, this goal was not quite achieved and a small residual

(and entirely artificial) UT-variation is still present. Except for the lowest values, the Kp-index in the beginning of the UT-day is systematically too high, while it is too low in the middle of the UT day. Because $\cos \phi$ changes sign when the sector polarity changes, the UT-variations of geomagnetic activity according to the merging theory should be opposite for the two polarities. During away polarity the activity should have a maximum of 1040 UT and during toward polarity maximum activity should occur at 2240 UT. Using a geomagnetic index devised by Mayaud (1967), the so-called am-index, it is possible to verify that such UT-variations exist. The am-index is derived from stations having a nearly uniform distribution in longitude and is therefore capable of showing the proper UT-variations. Figure 1 shows the result of an analysis by Svalgaard (1976a). Note that the observed variations are just as expected from the merging theory.

The magnitude of these UT variations is comparable to the systematic errors in the Kp index and the observed Kp dependence on UT is a result of superposing the real UT variations and the systematic errors. The net result is that the systematic errors enhance the UT-variation during toward polarity and decreases the UT-variation during away polarity. Figure 2 shows the result of this superposition. It is apparent that the UT-variation during away polarity indeed is completely masked by the residual systematic errors in Kp. One could then conclude as did McDiarmid and Budzinski that Kp has different $\cos \phi$ dependence in different interplanetary sectors. Such a conclusion is formally correct but does not mean that geomagnetic activity has different $\cos \phi$ dependence for opposite polarities.

The present author (Svalgaard, 1976b) has recently proposed that the Kp index be replaced by Mayaud's Km-index (Km being derived from am, as Kp is related to the ap-index). The investigation by McDiarmid and Budzinski, which is commented upon in this note, is a good indication that such replacement is strongly needed.

Acknowledgements

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Figure Captions

- Figure 1** Universal time variations of geomagnetic indices a_n , a_m , and a_s . The interplanetary magnetic field polarity (measured by spacecraft during 1962-1970) was used to divide the data into two groups: Away polarity (open circles) and Toward polarity (filled circles). In the righthand panel the difference between the universal time variations (away-toward) is shown. (After Svalgaard, 1976a.)
- Figure 2** Universal time variations of K_p for different sector polarity: Away (open circles) and Toward (filled circles). The bottom panel shows the average UT variation of K_p with no regard of the polarity. The average variation is consistent with the result of Michel (1964) using data before 1962 only.

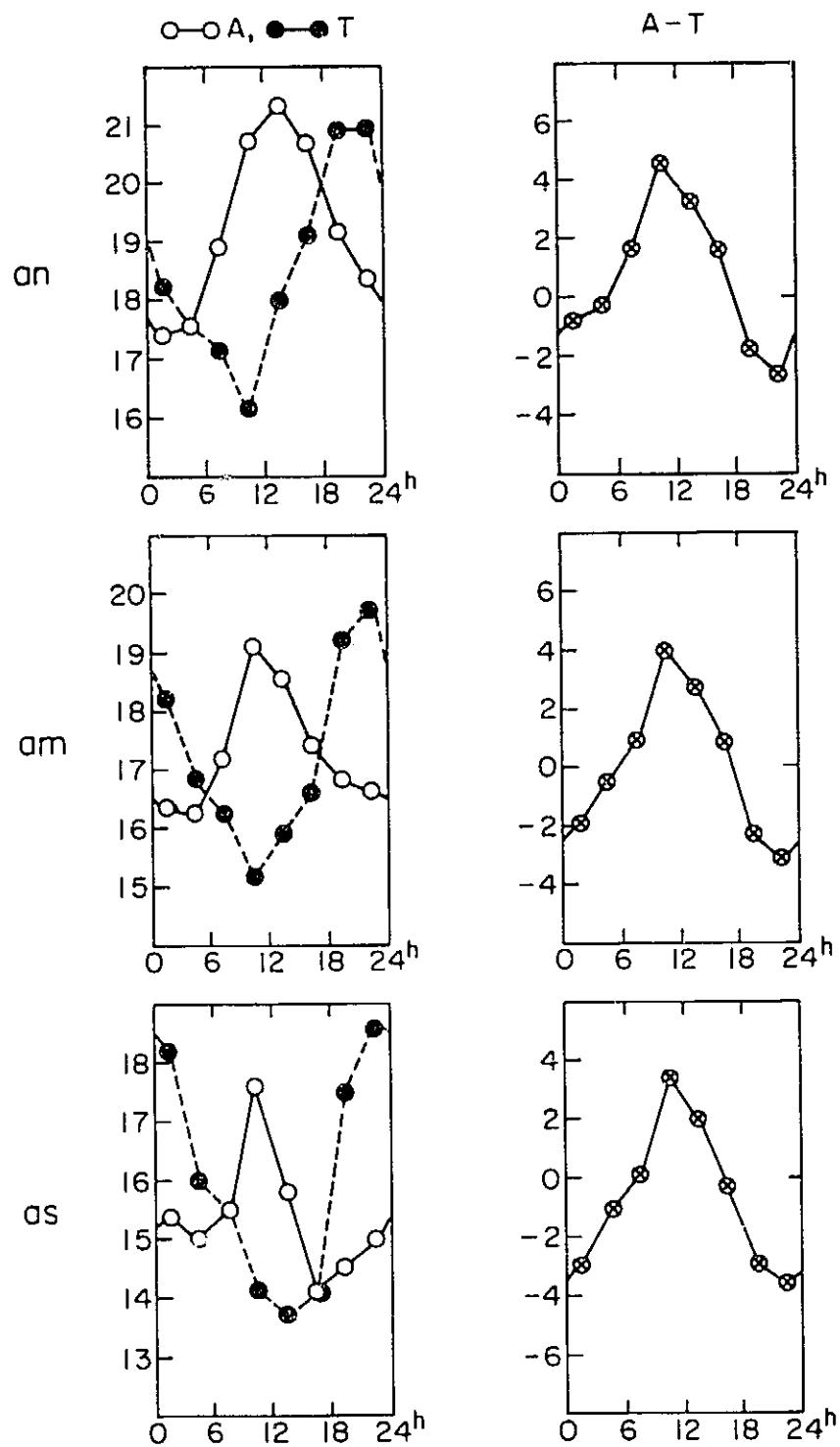


Figure 1

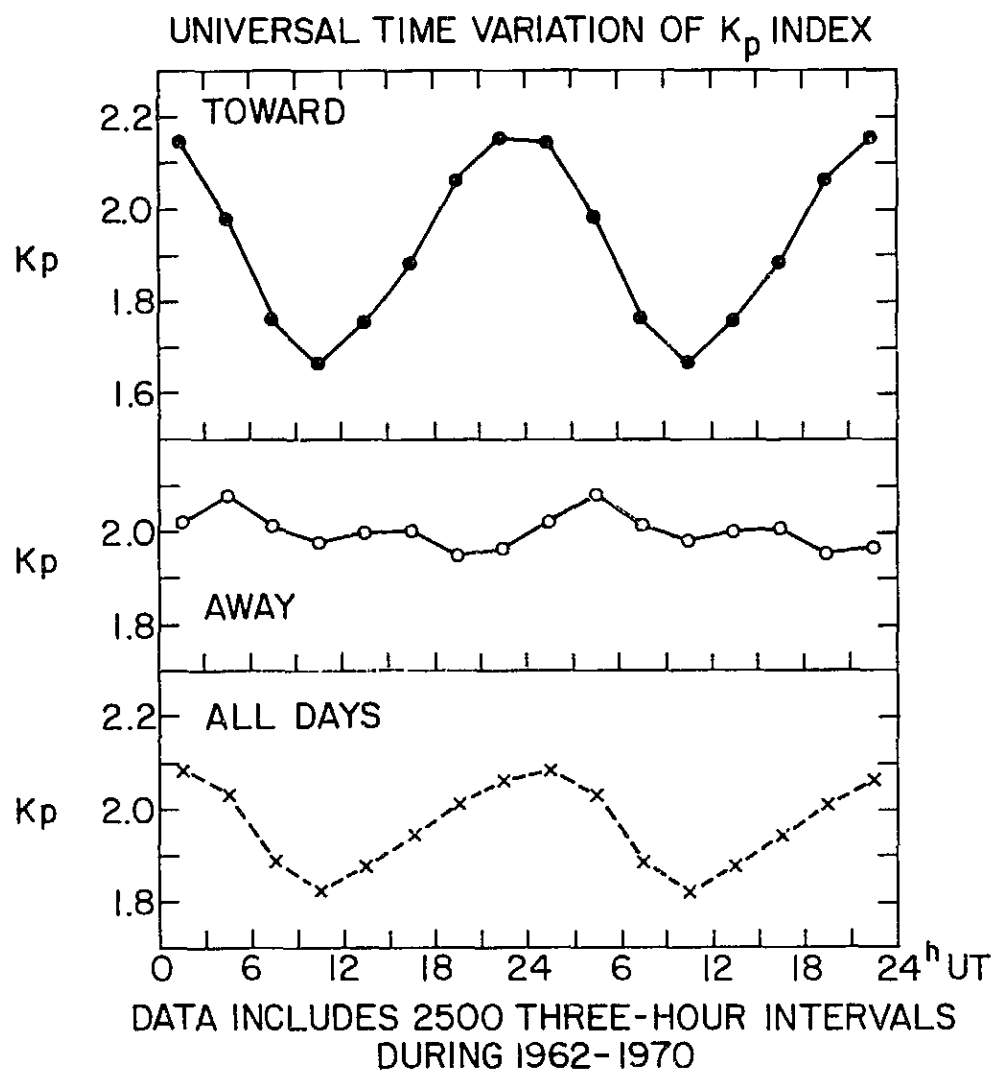


Figure 2